General Physics II: Tutorial Material

Lecture 6 on Chapter 7 (First law and thermal processes)

Reminder: The first law of Thermodynamics states that the variation of internal energy of a system is

$$\Delta E_{int} = Q - W, \quad (1)$$

where Q is the **heat absorbed by** the system and W is the **work done by** the system.

1) Suppose 2.60 mol of an ideal gas with a volume and temperature, $V_1 = 3.50m^3$ and $T_1 = 290K$, respectively, is allowed to expand isothermally to $V_2 = 7.00m^3$ at $T_2 = 290K$. Determine (a) the work done by the gas, (b) the heat going into the gas, and (c) the change in the internal energy of the gas.

2) An n mole of ideal gas expands adiabatically from a volume of V_i to V_f. Initially, the pressure was P_i. Determine:

1. the work done by the gas
2. the heat change of the gas
3. the change of internal energy from the first law of thermodynamics and
4. show that the internal energy obtained in the previous part is identical to $\Delta E_{int} = nC_V \Delta T$.

3) An ideal gas is at the state A: (V_a, P_a, T_0). By expanding the volume to through an isothermal process, the state changes to B: (V_b, P_b, T_0), while with an adiabatic process, the state changes to C: (V_b, P_c, T_c). Which pressure is higher, P_b or P_c? Which temperature is higher, T_0 or T_c? Why does the temperature change in the adiabatic process?

4) For an n-mole of ideal gas, two isothermal lines, t and t', at temperatures T_1 and T_2 in Kelvin respectively, and two adiabatic lines, a and a', are crossing at the four points, A, B, C and D, in the volume (V) versus pressure (P) diagram, as shown in Fig. 1. The heat in the process $A \to B$ is denoted by Q_{ab} and in the process $C \to D$, Q_{cd}. Show that the ratio, $\frac{Q_{ab}}{Q_{cd}}$, depends only on T_1 and T_2.

5) Let us consider a mole of a substance at temperature T_0 and pressure P_0 such that both liquid and gas phases coexist. The gaseous phase can be considered as an ideal gas. The molar volume v_l of the liquid phase is negligible compared to the molar volume v_g of the gas phase, i.e. $v_l \ll v_g$. Furthermore, we assume that the molar latent heat of vaporization l is independent of the temperature and pressure. Determine an expression for the pressure P(T) along the phase coexistence curve.

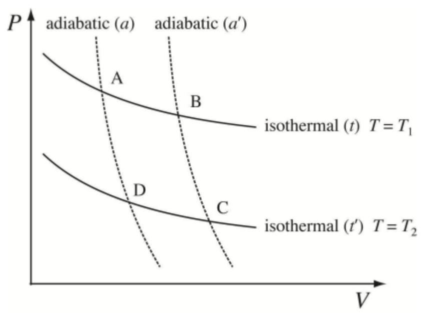

Figure 1: PV diagram for task 4